WHAT IS CLAIMED IS:

1. A wobble demodulator for reproducing digital information from an optical recording medium in which a track is formed in accordance with a wobble signal that is MSK-modulated so as to contain the digital information by a carrier signal with a predetermined frequency and a sine wave signal with a frequency different from that of the carrier signal, comprising:

a wobble signal detector for detecting a wobble signal of the track from the optical recording medium;

a carrier signal detector for detecting the carrier signal based on the wobble signal detected by the wobble signal detector;

a multiplier for multiplying the carrier signal detected by the carrier signal detector by the wobble signal detected by the wobble signal detector and outputting a multiplied output;

a MSK detector for detecting a MSK modulation mark having a phase or a frequency different from that of the carrier signal, based on an integrated value obtained by integrating the multiplied output from the multiplier on a predetermined section basis; and

a MSK synchronization detector for detecting a synchronization position with respect to the digital information, based on the MSK modulation mark detected by the MSK detector,

wherein the MSK detector compares a continuous predetermined number of absolute values of the integrated values with a first threshold value for detecting a central portion of the MSK modulation mark, a second threshold value for detecting leading and trailing edges of the MSK modulation mark, and a third threshold value for detecting non-modulated portions before and after the MSK modulation mark, and detects the MSK modulation mark based on a pattern of a comparison result.

2. The wobble demodulator according to claim 1, wherein the continuous predetermined number of the integrated values are calculated by integrating only a negative value of the multiplied output from the multiplier on a half-period basis of the carrier signal.

3. The wobble demodulator according to claim 1, further comprising a decoder for decoding the digital information based on the synchronization position detected by the MSK synchronization detector and the multiplied

output from the multiplier.

4. The wobble demodulator according to claim 1, wherein the first threshold value is higher than the second threshold value, and the second threshold value is higher than the third threshold value.

5. The wobble demodulator according to claim 1, further comprising a decoder for decoding the digital information based on the synchronization position detected by the MSK synchronization detector and the integrated value obtained by integrating the multiplied output from the multiplier on a predetermined section basis.

6. The wobble demodulator according to claim 5, wherein the decoder decodes the digital information based on a position at which the integrated value is minimum.

7. The wobble demodulator according to claim 1, wherein the MSK modulation mark is inserted in a predetermined position of the wobble signal.

8. The wobble demodulator according to claim 5, wherein the decoder decodes the digital information based on a sign of a difference value between a first sum obtained by summing integrated values in a MSK modulation mark section corresponding to data "1" of the digital information and a second sum obtained by summing integrated values in a MSK modulation mark section corresponding to data "0".

9. The wobble demodulator according to claim 8, wherein MSK modulation marks are disposed in the track at a predetermined interval as bit synchronization marks of the digital information, and

the decoder detects a bias of an integrated value in a bit synchronization mark section, and shifts a section in which the first sum is obtained or a section in which the second sum is obtained in accordance with a detection result.

10. The wobble demodulator according to claim 9, wherein the decoder detects a bias of the integrated value based on a sign of the integrated value in the bit synchronization mark section and a comparison result between an

integrated value in a central portion of the bit synchronization mark and an integrated value in leading and trailing edges of the bit synchronization mark.

11. A wobble demodulator for reproducing digital information from an optical recording medium in which a track, for recording data in accordance with a wobble signal modulated so as to represent digital information by a combination of a modulation signal that is frequency-modulated or phase-modulated and a carrier signal that is not frequency-modulated or phase-modulated, is wobbled to be formed, comprising:

a wobble signal detector for detecting a wobble signal in accordance with wobbling of the track from the optical recording medium;

a wobble PLL for detecting the carrier signal based on the wobble signal detected by the wobble signal detector;

a PLL lock determiner for detecting a lock state of a PLL representing a synchronization state in a frequency and a phase between the wobble signal and the carrier signal; and

a decoder for reproducing address information by decoding the wobble signal detected by the wobble signal detector and the carrier signal detected by the wobble PLL in accordance with a detection result of the PLL lock determiner,

wherein the decoder is operated so as to detect and lock a synchronization position with respect to the digital information when the PLL lock determiner detects a PLL lock, and is operated so as to unlock the locked synchronization position when the PLL lock determiner detects a PLL unlock.

12. The wobble demodulator according to claim 11, wherein the wobble PLL includes a voltage control transmitter for generating a wobble clock obtained by multiplying a frequency of the carrier signal,

the PLL lock determiner includes a period measurement unit for measuring a period of the wobble signal detected by the wobble signal detector based on the wobble clock generated by the voltage control transmitter, and

the PLL lock determiner detects a frequency lock when a sum or an average value of the period of the wobble signal measured by the period measurement unit in a predetermined section is in a first range, and detects

a frequency unlock when the sum or the average value is out of a predetermined second range.

13. The wobble demodulator according to claim 11, wherein the PLL lock determiner includes an exclusive OR integrator for integrating a result of an exclusive OR between a wobble binarized signal obtained by binarizing the wobble signal and a carrier binarized signal obtained by binarizing the carrier signal in a predetermined section, and

the PLL lock determiner detects a phase lock when an integrated value obtained by the exclusive OR integrator is smaller than a predetermined first threshold value, and detects a phase unlock when the integrated value is larger than a predetermined second threshold value.

14. The wobble demodulator according to claim 11, wherein the wobble PLL includes a wobble period averaging unit for generating an averaged wobble signal obtained by averaging a period of the wobble signal detected by the wobble signal detector, and

the wobble PLL generates the carrier signal based on the averaged wobble signal generated by the wobble period averaging unit in a state where the PLL lock determiner has not detected a frequency lock, and generates the carrier signal based on the wobble signal detected by the wobble signal detector in a state where the PLL lock determiner has detected a frequency lock.

15. The wobble demodulator according to claim 11, wherein in the optical recording medium, the digital information is composed on a predetermined information block basis having a synchronization signal containing a plurality of sink patterns, and

when a predetermined number or more of the sink patterns are detected from the synchronization signal in one information block, the decoder is operated so as to lock a synchronization position based on detection positions of the sink patterns.

16. The wobble demodulator according to claim 11, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a plurality of sink patterns, and

when information blocks in which a predetermined number or more of the sink patterns are not detected from the synchronization signal are continued a predetermined number of times, the decoder is operated so as to unlock a synchronization position.

17. The wobble demodulator according to claim 11, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, and

when information blocks in which a position of a sink pattern detected from the synchronization signal is shifted from a synchronization position previously detected are continued a predetermined number of times, the decoder corrects the synchronization position by a shifted amount.

18. The wobble demodulator according to claim 11, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, data, and an error correction code of the data,

the decoder includes an error corrector for correcting an error of the data based on the error correction code, and

the decoder is operated so as to unlock a synchronization position when data reproduced in an information block in which a synchronization position is detected first is not error-correctable.

19. The wobble demodulator according to claim 11, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, data, and an error correction code of the data,

the decoder includes an error corrector for correcting an error of the data based on the error correction code, and

the decoder is operated so as to unlock a synchronization position when an information block in which reproduced data is not error-correctable is continued a plurality of times.

20. An optical disk apparatus comprising:

an optical head for irradiating an optical recording medium with a light beam and converting the light beam reflected from the optical recording

medium to an electric signal; and

the wobble demodulator of claim 1 for reproducing digital information based on the electric signal converted by the optical head.

21. A wobble demodulation method for reproducing digital information from an optical recording medium in which a track is formed in accordance with a wobble signal that is MSK-modulated so as to contain the digital information by a carrier signal with a predetermined frequency and a sine wave signal with a frequency different from that of the carrier signal, comprising:

detecting a wobble signal of the track from the optical recording medium;

detecting the carrier signal based on the wobble signal detected by the detection of the wobble signal;

multiplying the carrier signal detected by the detection of the carrier signal by the wobble signal detected by the detection of the wobble signal and outputting a multiplied output;

detecting a MSK modulation mark having a phase or a frequency different from that of the carrier signal, based on an integrated value obtained by integrating the multiplied output in the multiplication on a predetermined section basis; and

detecting a synchronization position with respect to the digital information, based on the MSK modulation mark detected in the detection of the MSK,

wherein in the detection of the synchronization position, a continuous predetermined number of absolute values of the integrated values are compared with a first threshold value for detecting a central portion of the MSK modulation mark, a second threshold value for detecting leading and trailing edges of the MSK modulation mark, and a third threshold value for detecting non-modulated portions before and after the MSK modulation mark, and detects the MSK modulation mark based on a pattern of a comparison result.

22. The wobble demodulation method according to claim 21, wherein the continuous predetermined number of the integrated values are calculated by integrating only a negative value of the multiplied output in the multiplication on a half-period basis of the carrier signal.

23. The wobble demodulation method according to claim 21, further comprising decoding the digital information based on the synchronization position detected in the detection of the MSK synchronization and the multiplied output in the multiplication.

24. The wobble demodulation method according to claim 21, wherein the first threshold value is higher than the second threshold value, and the second threshold value is higher than the third threshold value.

25. The wobble demodulation method according to claim 21, further comprising decoding the digital information based on the synchronization position detected by the detection of the MSK synchronization and the integrated value obtained by integrating the multiplied output in the multiplication on a predetermined section basis.

26. The wobble demodulation method according to claim 25, wherein in the decoding, the digital information is decoded based on a position at which the integrated value is minimum.

27. The wobble demodulation method according to claim 21, wherein the MSK modulation mark is inserted in a predetermined position of the wobble signal.

28. The wobble demodulation method according to claim 25, wherein in the decoding, the digital information is decoded based on a sign of a difference value between a first sum obtained by summing integrated values in a MSK modulation mark section corresponding to data "1" of the digital information and a second sum obtained by summing integrated values in a MSK modulation mark section corresponding to data "0".

29. The wobble demodulation method according to claim 28, wherein MSK modulation marks are disposed in the track at a predetermined interval as bit synchronization marks of the digital information, and

in the decoding, a bias of an integrated value in a bit synchronization mark section is detected, and a section in which the first sum is obtained or a section in which the second sum is obtained is shifted in accordance with a detection result.

30. The wobble demodulation method according to claim 29, wherein in the decoding, a bias of the integrated value is detected based on a sign of the integrated value in the bit synchronization mark section and a comparison result between an integrated value in a central portion of the bit synchronization mark and an integrated value in leading and trailing edges of the bit synchronization mark.

31. A wobble demodulation method for reproducing digital information from an optical recording medium in which a track, for recording data in accordance with a wobble signal modulated so as to represent digital information by a combination of a modulation signal that is frequency-modulated or phase-modulated and a carrier signal that is not frequency-modulated or phase-modulated, is wobbled to be formed, comprising:

detecting a wobble signal in accordance with wobbling of the track from the optical recording medium;

detecting the carrier signal based on the wobble signal detected in the detection of the wobble signal;

detecting a lock state of a PLL representing a synchronization state in a frequency and a phase between the wobble signal and the carrier signal; and

reproducing address information by decoding the wobble signal detected in the detection of the wobble signal and the carrier signal detected in the detection of the carrier signal in accordance with a detection result in the determination of the PLL lock,

wherein the decoding is performed so as to detect and lock a synchronization position with respect to the digital information when a PLL lock is detected in the determination of the PLL lock, and is performed so as to unlock the locked synchronization position when a PLL unlock is detected in the determination of the PLL lock.

32. The wobble demodulation method according to claim 31, wherein the detection of the wobble PLL includes generating a wobble clock obtained by multiplying a frequency of the carrier signal,

the determination of the PLL lock includes measuring a period of the wobble signal detected by the detection of the wobble signal based on the

wobble clock generated in the generation of the wobble clock, and

in the determination of the PLL lock, a frequency lock is detected when a sum or an average value of the period of the wobble signal measured in the measurement of the period in a predetermined section is in a first range, and a frequency unlock is detected when the sum or the average value is out of a predetermined second range.

33. The wobble demodulation method according to claim 31, wherein the determination of the PLL lock includes integrating a result of an exclusive OR between a wobble binarized signal obtained by binarizing the wobble signal and a carrier binarized signal obtained by binarizing the carrier signal in a predetermined section, and

in the determination of the PLL lock, a phase lock is detected when an integrated value obtained in the exclusive OR integration is smaller than a predetermined first threshold value, and a phase unlock is detected when the integrated value is larger than a predetermined second threshold value.

34. The wobble demodulation method according to claim 31, wherein the detection of the carrier signal includes generating an averaged wobble signal obtained by averaging a period of the wobble signal detected in the detection of the wobble signal, and

in the detection of the carrier signal, the carrier signal is generated based on the averaged wobble signal generated in the averaging of the wobble period in a state where a frequency lock has not been detected in the determination of the PLL lock, and the carrier signal is generated based on the wobble signal detected in the detection of the wobble signal in a state where a frequency lock has been detected in the determination of the PLL lock.

35. The wobble demodulation method according to claim 31, wherein in the optical recording medium, the digital information is composed on a predetermined information block basis having a synchronization signal containing a plurality of sink patterns, and

when a predetermined number or more of the sink patterns are detected from the synchronization signal in one information block, a synchronization position is locked based on detection positions of the sink patterns in the decoding.

36. The wobble demodulation method according to claim 31, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a plurality of sink patterns, and

when information blocks in which a predetermined number or more of the sink patterns are not detected from the synchronization signal are continued a predetermined number of times, a synchronization position is unlocked in the decoding.

37. The wobble demodulation method according to claim 31, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, and

when information blocks in which a position of a sink pattern detected from the synchronization signal is shifted from a synchronization position previously detected are continued a predetermined number of times, the synchronization position is corrected by a shifted amount in the decoding.

38. The wobble demodulation method according to claim 31, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, data, and an error correction code of the data,

the decoding includes correcting an error of the data based on the error correction code, and

in the decoding, a synchronization position is unlocked when data reproduced in an information block in which a synchronization position is detected first is not error-correctable.

39. The wobble demodulation method according to claim 31, wherein in the optical recording medium, the digital information is configured on a predetermined information block basis having a synchronization signal containing a predetermined sink pattern, data, and an error correction code of the data,

the decoding includes correcting an error of the data based on the error correction code, and

in the decoding, a synchronization position is unlocked when an information block in which reproduced data is not error-correctable is continued a plurality of times.